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GROWTH, MORTALITY, INCREMENT, AND CUTTING CYCLES IN NEW MEXICO PONDEROSA PINE

A previous report dealing with ponderosa pine in Arizona[1/] has shown that net increment accelerates during the first decade after cutting, declines moderately during the second decade and rapidly during the third decade, reaching a third-period level about 50 percent below that of the first. The decline is attributed to rising mortality; to a build-up in numbers of slowly dying trees; and last but not least to stagnation in blackjack groups. Proposed remedies are: (1) Removal of more large yellow pines in the first cut; (2) Opening up blackjack groups in the first cut; and (3) A cutting cycle of not more than 20 years.

The present report analyzes growth and mortality in New Mexico stands. Two reasons call for separate treatment of data in the two States:

First, the stands are different. New Mexico stands are generally made up of more and smaller trees than are found in typical Arizona stands. The difference is attributed to distribution of precipitation. New Mexico forests receive less winter moisture, more during May and June, and a somewhat lower annual total than do the Arizona forests. The line of demarcation does not conform absolutely to the State line but nearly so. The transition from one type of rainfall distribution to the other is gradual, but so rapid that an interval of 200 miles in an east-west direction is accompanied by a marked change in precipitation

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1/G. A. Pearson. Cutting cycles in ponderosa pine. Manuscript to be published in Journal of Forestry.

records. The New Mexico type of distribution is conducive to lighter volumes per acre, more but smaller trees, and better reproduction than prevail in Arizona.

The second reason for separate treatment of data in the two States lies in differences in the character of plots, in turn attributable to circumstances at the time the areas were logged. In both cases the data are derived from long-time records of sample plots. The Arizona plots, however, are relatively large areas measuring as high as 480 acres, whereas the New Mexico plots are much smaller, the largest covering only 14 acres. Although size, per se, may not justify distinction if all plots were carefully selected, this provision cannot be said to have been satisfied. Plots were located wherever cutting operations happened to be in progress at the time the sample plot program was put into action. In Arizona, large national forest operations afforded opportunities to select large and fairly typical areas; but in New Mexico all the operations were small, thus affording little latitude for selection.

THE NEW MEXICO PLOTS

Twelve small ponderosa pine plots were established within four national forests between 1910 and 1914. Unlike some of the early Arizona plots, all trees were numbered at the beginning. Measurements have been made at 5-year intervals, except in a few instances as noted. One plot, Gila S1A, has been abandoned because a highway was built through it. The results are expressed in tables 1 to 8.

Nearly all of the plots were established by H. D. Burrall under direction of the Regional Office of Forest Management. They were later taken over by the Fort Valley Forest Experiment Station. Remeasurements have been made mainly by Hermann Krauch with the assistance of experiment station personnel and officers on the forests concerned.

Compilations which have made possible the presentation of data in the accompanying tables have been made by Geraldine Peterson, Senior Statistical Clerk of the Southwestern Forest and Range Experiment Station.

Description of Plots

Jemez S1-A. Location: NE 1/4 Sec. 8, T. 19 N., R. 6 E. Relatively poor site, tufa formation, shallow soil. Cutting very light, only ties being removed. Few trees were released. Mistletoe is prevalent. A second cutting in order inasmuch as openings are well restocked. (Krauch 1931.)

Jemez S2-A. Location: SE 1/4 Sec. 22 and NE 1/4 Sec. 27, T. 19 N., R. 6 E. Lower margin of pine type, as indicated by pinon and juniper in mixture. Good site at head of draw; granular soil. Cutting somewhat heavier than S1-A. Area was cut over for saw timber before being cut for ties. Mistletoe light. Considerable advance reproduction at time of logging but few seedlings have come in since. (Krauch 1931.)

Jemez S3-A. Location: Sec. 2, T. 18 N., R. 5 E. and Sec. 35, T. 19 N., R. 5 E. Site more typical of ponderosa pine type than S1-A or S2-A, clayey soil. Cutting corresponds closely to standards of group selection method; most mature trees were cut while blackjack groups were left intact, very few trees being released. Mistletoe is common. Advance reproduction good and further reproduction has followed cutting. (Krauch 1931.)

Pecos S1-A. Location: SW 1/4 Sec. 34, T. 17 N., R.14 E. Plot lies on limestone ridge in upper transition of ponderosa pine type. Cutting very light, many of reserved trees defective and few released. Severe mistletoe infection. Fair reproduction of both pine and Douglas-fir. Brush of oak and mountain mahogany are being crowded out by conifers. (Krauch 1931.)

Pecos S2-A. Location: NW 1/4 Sec. 34, T. 17 N., R. 14 E. Lower south slope near canyon bottom, soil deep and porous. Douglas-fir, white fir, and limber pine in mixture with ponderosa pine. Cutting light, leaving many mature and defective trees. Less mistletoe than on S1-A. Good reproduction of pine, Douglas-fir, and white fir. Besides the conifers, there are oak, mountain mahogany, clumps of willow, cottonwood, and ninebark. (Krauch 1931.)

Carson, Cienega Plot. Location: near Tres Ritos. Cutting classed as group selection, retaining relatively many yellow pines up to 25 inches d.b.h. Good reproduction after cutting is attributed to adequate seed trees and the sandy soil. Pine saplings noted as growing well in the midst of oak brush. Mistletoe was recorded on 52 percent of the trees in 1929. (Krauch 1929.)

Carson, Amole Plot. Location: NE 1/4 NE 1/4 Sec. 36, T. 23 N., R. 12 E. Cutting removed all of the yellow pine and opened up the blackjack groups, leaving only a few trees of sawlog size. A stand of small blackjack supplemented by 72 8-11 inch poles per acre constitutes the growing stock which in 1914 measured only 1,302 board feet. (Krauch 1929.) Notwithstanding the abundance of blackjack and poles, the stand contains openings which have not restocked since cutting. Krauch, in a memorandum dated December 16, 1933, points to this plot as an example of the advantages of numerous trees in the younger age classes.

Cibola (Datil) S1-A and S1-B. Location: SE 1/4 Sec. 11, T. 5 S, R. 7 W. Plots adjoin and lie near upper limits of ponderosa pine type; the site is regarded as poor for ponderosa pine; soil is granular (decomposed granite). Douglas-fir and limber pine are associated with the pine and in general appear more at home on the site. Douglas-fir and

limber pine are also prominent in the reproduction. Cattle grazing is heavy but the conifers are damaged but little. Cutting, though heavy on a volume basis, left many yellow pines over 12 inches d.b.h. These trees are, however, of poor quality. (Krauch 1925.)

Cibola (Datil) S2-A. Location: NW 1/4 Sec. 9, T. 5 S., R. 7 W. An alluvial flat of deep soil, good site. This plot is considered much more typical of ponderosa pine than are the other two Datil plots. According to Krauch, reproduction in 1925 was poor, a condition attributed largely to heavy grazing. (Hornibrook reported the same condition in 1935.) Cutting was fairly typical of group selection.

Gila S2-A. Location: NW 1/4 Sec. 31, T. 15 S., R. 13 W. Site is representative of ponderosa pine type on gravelly and shallow soil. Reserve stand consists largely of mature trees which are short and scrubby looking. Cutting was representative of conservative group selection. About 35 percent of the trees are Arizona pine (Pinus arizonica). Restocking is practically complete. Although many of the old reserved trees are badly infested with mistletoe, the young growth is relatively free of it. Tip moth damage has been severe in past few years. Not only seedlings but also tall saplings have been attacked. (Krauch 1932.)

Reserved Stands

Table 1 gives a break-down of the stand in each plot by broad diameter classes, also separating the two age classes, blackjack and yellow pine. Compared with Arizona plots, the virtual absence of reserved trees over 30 inches d.b.h. and even in diameters between 25 and 30 inches is noteworthy. A feature in the Santa Fe (Jemez and Pecos) plots is the heavy reserve, amounting in three instances to over 5,000 board feet per acre, accounted for by leaving a large number of yellow

pines too large for hewn ties. Although no record of the stand before cutting is available, the cutting on these three plots has been characterized as very light.

Pole classes were well represented on all the plots at the time of cutting; most of the plots were also described in the early periods as having good reproduction in the seedling and sapling stages.

In common with Arizona plots, several of the New Mexico plots are suffering from mistletoe infection.

Relative situation ranges from the lower to the upper transition zones of the ponderosa pine type, plots of the latter class being characterized by an admixture of Douglas-fir, white fir, and limber pine.

Table 1 shows, in addition to number of trees by diameter classes, the board-foot volume of each class at the beginning and the end of the record,- 30 years for the Santa Fe and Cibola plots, 25 years for the Gila plots, and 19 and 20 years for the two Carson plots. These volumes represent the same trees at beginning and end of the period, notwithstanding that diameters change over a period of years; no allowance has been made for mortality. In other words, the difference in volume of a diameter class on the Jemez, for example, tells the net increment of that class, and thus indicates the relative efficiency of trees of different diameter classes. As may be expected, the increment on a percentage basis declines with increasing diameter, giving minus values in some cases for the trees which were over 25 inches d.b.h. when the plot was established. New trees, or those which entered the 12-inch class after cutting, contribute substantially to the volume in all cases.

Periodic Gross and Net Increment

The difference between gross and net increment is, of course, accounted for by mortality. Although net increment is the ultimate measure of yield, gross increment is a better measure of growth capacity.

Periodic gross increment, expressed in table 2, shows a surprising fluctuation through the series of 5-year periods, but a persistent downward trend is plainly discernible. The characteristic acceleration from the first to the second 5-year period in the Arizona plots is absent in most of the New Mexico plots. A possible explanation is the abundance of poles in New Mexico, which would tend to neutralize the effect of cutting on root competition as far as the larger trees are concerned. That the poles themselves were benefited by the cuttings is evident from their increment as revealed in table 5. On some of the plots, notably four of those on the Santa Fe, cutting was probably too light to bring about substantial relief from competition.

Gross increment during the first 10 years commonly approaches 130 board feet and attains a maximum of 155 feet on Cibola S2-A. This fact alone is sufficient to demonstrate that the sites have the capacity to produce well under correct management. As in the Arizona plots, the task of management is to forestall mortality and keep the living trees growing.

Mortality

Erratic is the word which best describes the periodic trend of mortality in table 6. Undoubtedly this extreme fluctuation is explained in large measure by the small size of the plots, because mortality is by its very nature spotty in distribution. But the total loss over a 30-year period is generally much greater than on the Arizona plots, indicating the presence of some factor peculiar to the New Mexico plots. On the Santa Fe plots, this factor is probably the light

cutting and the high proportion of yellow pine in the reserve stand. In the Cibola (Datil) plots the reserve was not large but two of them (S1-A and S1-B) have been characterized as poor sites not typical of any considerable portion of the pine type. The fact that these two Cibola plots contained six yellow pines per acre in the 12-15 inch class and one of them had almost as many in the 8-11 class indicates an abnormal condition.

Yellow pine generally suffered greater loss than blackjack, and mortality on a volume basis rises with diameter (table 8). These relationships are in accord with findings in Arizona.

Wind is by far the greatest cause of mortality, followed by mistletoe, lightning, and insects in approximately the order named (table 7). The relative magnitude of the several agents, however, varies with plots. The tremendous losses on the three Cibola plots during the third period were caused by a wind storm.

As in the virgin stand at Fort Valley (S6), extremely high mortality tends to be followed by a period of light mortality, indicating that the most susceptible trees go out in "waves," leaving the stand temporarily in more vigorous condition.

Original Trees

As on the Arizona plots, the stand has been broken down into "original" and "new" trees. Original trees are those which were in the 12-inch class or larger in the first measurement; new trees are those which have grown into the 12-inch class. As may be seen in table 1, not only yellow pine but also large numbers of blackjack are included in the class of original trees.

Gross increment of original trees declines even more rapidly than gross increment of the stand as a whole (tables 2 and 4 and fig. 1).

The downward trend is on a par with the worst of the Coconino plots. It is obvious that but for the presence of a large class of new trees, net increment on all but a few plots would soon become a minus quantity.

New Trees

The presence of a large pole class in all of the New Mexico plots at the beginning of the record augured well for the stands as a whole except where poles were left under the domination of old trees.

On the majority of plots the new trees are now contributing more net increment than are the original trees (tables 4 and 5). An extreme example is the Amole plot on the Carson, in which the new trees were adding 133 board feet per acre annually in the fourth period. It should be noted that this plot had no trees over the 20-inch class, but that there were 71.7 in the 8-11 inch class. Decline of the original trees was greater on this plot than on the Cienega plot, but the latter had fewer large poles, and consequently its net increment in the 20th year was only 97 board feet as against 189 on the Amole plot.

The periodic contribution by new trees fluctuates greatly because it is determined largely by chance. If it happens that many trees just below 11.6 inches d.b.h. are found on an area at the end of a period, they will add much to the increment of the next period because in the record the board-foot volume of such a tree leaps from 0 to about 40. If, on the other hand, no trees reach the 11.6 mark the only new-tree increment is the growth of trees which entered this class in former periods.

An important element of chance in the increment of new trees is their release by the death of older trees. This factor may have figured in Cibola S2-A. In the third and fourth periods new trees on this plot accounted for an average annual increment of only 14 board

feet. During these same periods, mortality attained highs of 70 and 41 board feet respectively; and in the fifth and sixth periods the annual increment of new trees rose to 66 feet and 73 feet.

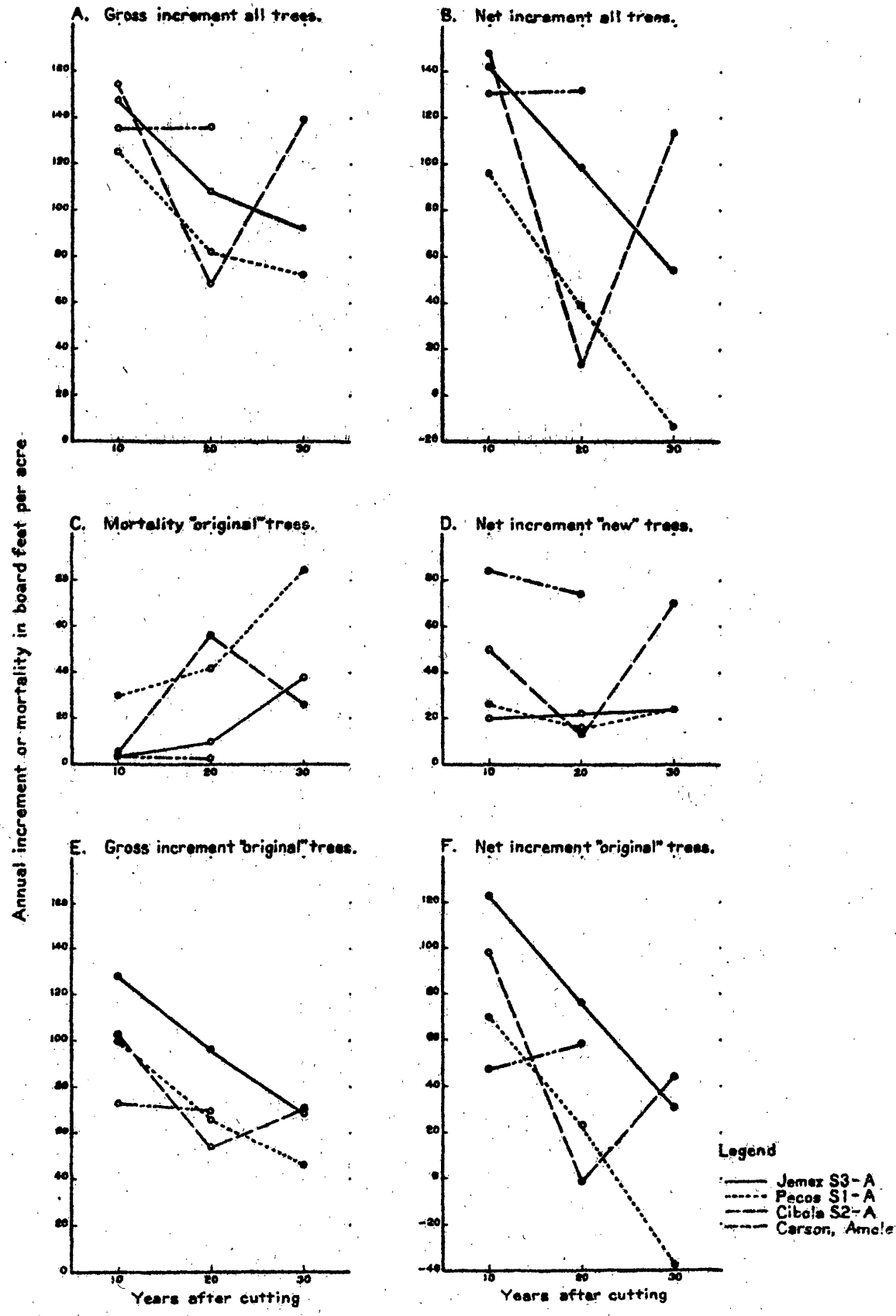
Conclusions and Recommendations

Perhaps the New Mexico plots are too small or too few in number to give an accurate picture of what is taking place. This applies especially to mortality. Nevertheless, (with the possible exception of the Amole plot which had a very light reserve) they all point in the same direction, namely, to a progressive decline in both gross and net increment of that portion of the stand which was in the 12-inch class or larger at the beginning of the record. The Arizona plots show the same thing. All records indicate that but for the presence of a substantial pole class, net increment after 20 years would fall to a very low level. The apparent upsurge of Cibola plot S2-A in the last two periods does not disprove this statement because new trees account for all of it. The real test of what the old reserve is doing is seen in the net increment of original trees. Figure 1 illustrates impressively the low efficiency of an old stand and the compensating influence of a large pole class.

Only two of the eight plots for which 30-year records are available register a mean annual net increment of as much as 60 board feet during that period. At the end of 20 years, six out of eleven plots are over the 60-foot average, four are over 80 board feet, one stands at 120, and one at 131 board feet.

Reserved volume is a poor criterion of increment. The highest increment of the entire series was registered by the Amole plot which had the lowest reserve as expressed in board feet. In 20 years the volume of this plot increased from 1,302 to 3,925

Increment and mortality by 10-year periods during 30 years after cutting on four ponderosa pine sample plots in New Mexico.



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board feet, the increment being attributable largely to trees below 16 inches d.b.h. in the first measurement.

A large reserve in the higher diameters is advantageous only when needed for a future cut. The economy of holding large trees, however, is questionable. As rapidly as possible the stand should be shaped with a view toward realizing future cuts from the growth of small stems.

All the New Mexico plots point to advantages of a short cutting cycle. A second cutting in 20 years, however, would not have forestalled heavy mortality in all the plots. On the Santa Fe, for instance, results plainly indicate the need for removal of a larger proportion of the yellow pines in diameter classes above 20 inches in the first cutting. All of the plots would have benefited from a general opening up of both yellow pine and blackjack groups.

Recommendations for cutting in stands similar to the New Mexico plots may be summarized as follows:

(1) Cut all yellow pines above 20 inches d.b.h. except that sound, healthy, and well spaced individuals of good form, up to 25 inches d.b.h., may be left. Larger stems may be left if needed for seed.

(2) Remove enough of the yellow pines below 21 inches to insure good spacing, always favoring individuals of the best form and physical condition.

(3) Cut blackjacks on an improvement basis, striving to improve spacing in groups by removal of the largest stems and any of inferior form and physical condition.

(4) Cut mistletoe-infected trees wherever so situated as to threaten infection of young age classes.

(5) Where Douglas-fir, white fir, and limber pine occur in mixture apply the same principles as in ponderosa pine except that white fir and limber pine should be cut to a lower diameter limit generally.

(6) Plan for a second cutting in not more than 20 years and preferably 10 years, wherever such a cut may be expected to yield as much as 1,000 board feet per acre. Future logging practice must become adjusted to lower volumes per cut and the utilization of smaller diameters.

Table 1.— Number of trees per acre in reserve stand by species and diameter classes on sample plots on the Santa Fe (Jemez and Pecos), Carson, Cibola (Datil), and Gila National Forests.

D.b.h. class	B.J.	Y.P.	D.F.	W.F.	L.P.	Total	Volume b.m. 1911	Volume b.m. 1941
	Number	Number	Number	Number	Number	Number		
Jemez S1-A - 6 acres, established 1911								
4-7	11.8	1.0				12.8	0)	470
8-11	12.7	4.8				17.5	0)	
12-15	10.8	4.5				15.3	1049	1775
16-20	2.2	12.5				14.7	2908	3333
21-25		3.4				3.4	1417	1135
26-30		0.3				0.3	232	269
31+		0.2				0.2	217	
Total	37.5	26.7				64.2	5823	6982
Jemez S2-A - 6 acres, established 1911								
4-7	5.8	0.4				6.2	0)	549
8-11	8.2	1.6				9.8	0)	
12-15	6.0	2.3				8.3	738	1351
16-20	2.0	6.3				8.3	2055	2451
21-25	0.2	2.0				2.2	1028	1231
Total	22.2	12.6				34.8	3821	5582
Jemez S3-A - 6 acres, established 1911								
4-7	14.3	0.2	0.2			14.7	0)	646
8-11	13.3	0.5				13.8	0)	
12-15	13.7	0	0.3			14.0	975	2069
16-20	5.2	0.5	0.1			5.8	1184	2098
21-25	2.0	1.0				3.0	1431	1902
26-30	0.2	0.8				1.0	882	702
Total	48.7	3.0	0.6			52.3	4472	7417
Pecos S1-A - 6 acres, established 1911								
4-7	12.8	1.0	0.5			14.3	0)	651
8-11	14.3	4.7	0.2			19.2	0)	
12-15	12.7	16.2	0.5			29.4	2392	3012
16-20	2.7	12.5	0.6			15.8	3126	3177
21-25		0.8				0.8	394	270
Total	42.5	35.2	1.8			79.5	5912	7110
Pecos S2-A - 6 acres, established 1911								
4-7	6.6	0.2	1.5	0.5		8.8	0)	467
8-11	5.4	3.8	1.3	0.2		10.7	0)	
12-15	2.3	9.2	1.5	0.4	0.3	13.7	1386	1672
16-20	1.0	11.5	1.7	0.8	0.2	15.2	3563	4123
21-25		1.2	1.3	0.3		2.8	1341	1162
Total	15.3	25.9	7.3	2.2	0.5	51.2	6290	7424

Table 1 (continued)

D.b.h. class	B.J.	Y.P.	D.F.	L.P.	Total	Volume b.m.	
	Number	Number	Number	Number	Number		
	Cibola (Datil) S1-A - 6 acres, established 1910						
						1910	1940
4-7	12.0	0.2	0.2	2.6	15.0	0)	544
8-11	11.3	2.3	0.5	2.7	16.8	0)	
12-15	3.5	6.1	1.0	0.7	11.3	732	957
16-20	0.2	2.7	1.3	0.6	4.8	853	704
21-25			0.4		0.4	150	68
26-30			0.3		0.3	219	136
Total	27.0	11.3	3.7	6.6	48.6	1954	2409
	Cibola (Datil) S1-B, - 6 acres, established 1910						
4-7	32.3	0.7	0.6	7.7	41.3	0)	633
8-11	19.5	5.5	1.7	2.8	29.5	0)	
12-15	4.4	5.8	0.5	1.2	11.9	729	863
16-20	0.5	2.0	0.3	0.5	3.3	654	692
21-25		0.3	0.4	0.3	1.0	366	301
26-30			0.3	0.2	0.5	338	199
Total	56.7	14.3	3.8	12.7	87.5	2087	2688
	Cibola (Datil) S2-A - 14.4 acres, established 1910						
4-7	19.6	0.1		0.4	20.1	0)	1341
8-11	23.1	0.9	0.1	0.1	24.2	0)	
12-15	10.5	2.9	0.1		13.5	997	1995
16-20	2.8	3.0	0.1	0.1	6.0	1192	1816
21-25	0.1	0.6		0.1	0.8	442	580
26-30		0.1			0.1	107	-
31+			0.1	0.1	0.2	244	-
Total	56.1	7.6	0.4	0.8	64.9	2982	5732

Table 1 - (continued)

D.b.h. class	B. J.	Y. P.	Total	Volume b.m.	
	Number	Number	Number		
Carson, Amole plot - 2.9 acres, established 1914					
				1914	1934
4-7	75.2		75.2	0)	1589
8-11	71.7		71.7	0)	
12-15	16.2		16.2	936	1690
16-20	2.1		2.1	366	656
Total	165.2		165.2	1302	3935
Carson, Cienega plot - 4 acres, established 1915					
				1915	1934
4-7	29.5		29.5	0)	371
8-11	23.0		23.0	0)	
12-15	8.5	1.3	9.8	610	992
16-20	8.0	2.5	10.5	1978	2827
21-25	0.5	0.5	1.0	484	566
Total	69.5	4.3	73.8	3072	4756
Gila S2-A - 6.4 acres, established 1912					
				1912	1937
4-7	7.5	1.1	8.6	0)	233
8-11	7.1	2.8	9.9	0)	
12-15	3.4	4.4	7.8	561	981
16-20	1.7	3.9	5.6	1020	1452
21-25		1.2	1.2	542	590
26-30		0.3	0.3	215	106
Total	19.7	13.7	33.4	2338	3362

Table 2.- Gross and net periodic annual increment on ponderosa pine sample plots. Santa Fe, Carson, Cibola, and Gila National Forests.

Forest	Plot	Record begun	Gross increment in board feet per acre by 5-year periods						Net increment in board feet per acre by 5-year periods					
			1	2	3	4	5	6	1	2	3	4	5	6
Santa Fe	Jemez													
	S1-A	1911	128	109	47	71	69	66	122	96	-81	22	54	35[1]
	S2-A	1911	125	129	60	74	55	57	67	115	28	68	55	19
	S3-A	1911	160	134	114	102	97	88	151	134	99	96	97	12
	Pecos													
	S1-A	1911	103	147	72	93	94	49	77	114	29	49	-25	-3
	S2-A	1911	106	121	59	71	82	52	79	93	35	12	27	-20
Carson	Amole	1914		135[2]	82	189				131[2]	75	189		
	Cienega	1915		93[3]	82	97				93[3]	74	97		
Cibola	S1-A	1910	69	63	35	21	61	30	69	60	-93	-13	44	24
	S1-B	1910	77	53	47	29	42	58	77	51	-126	19	42	58
	S2-A	1910	152	155	67	70	136	142	152	145	-3	29	125	101
Gila	S2-A	1912	71	56	29	51	44	-	71	56	29	51	-3	-

1/ Includes 15 feet cut in trespass.
2/ 10 years.
3/ 9 years.

Table 3.- Mean annual net increment in volume per acre and in percent on ponderosa pine sample plots, Santa Fe, Carson, Cibola, and Gila National Forests.

Forest	Plot	Area	Res. vol.	5 years		10 years		15 years		20 years		25 years		30 years	
		Acres	Ft.bm.	Ft.bm.	Pct.	Ft.bm.	Pct.	Ft.bm.	Pct.	Ft.bm.	Pct.	Ft.bm.	Pct.	Ft.bm.	Pct.
Santa Fe	Jemez														
	S1-A	6	5823	122	2.10	108	1.85	46	0.79	40	0.69	43	0.74	38	0.65
	S2-A	6	3821	67	1.75	91	2.38	70	1.83	70	1.83	67	1.75	59	1.54
	S3-A	6	4472	151	3.38	142	3.18	128	2.86	120	2.68	115	2.57	98	2.19
	Pecos														
	S1-A	6	5912	77	1.30	95	1.60	73	1.23	67	1.13	49	0.83	40	0.67
	S2-A	6	6290	79	1.25	86	1.37	69	1.10	55	0.87	49	0.78	38	0.60
Carson	Amole	2.9	1302			131	10.06	113	8.68	131	10.06				
	Cienega 1/	4	3072			93	3.03	86	2.80	89	2.90				
Cibola	S1-A	6	1954	69	3.53	65	3.33	12	0.61	6	0.31	13	0.67	15	0.76
	S1-B	6	2087	77	3.69	64	3.06	1	0.05	5	0.24	13	0.62	20	0.96
	S2-A	14.4	2982	152	5.10	149	5.00	98	3.29	81	2.71	90	3.02	92	3.09
Gila	S2-A	6.4	2338	71	3.04	64	2.74	52	2.22	52	2.22	41	1.75		

1/Cienega plot measured 9, 14, and 19 years after cutting.

Table 4.- Annual increment per acre of "original" trees or those which were 12 inches d.b.h. or larger at beginning of 30-year record (Santa Fe, Carson, Cibola, and Gila National Forests).

Forest	Plot	Acres	Gross increment in board feet per acre by 5-year periods						Net increment in board feet per acre by 5-year periods					
			1	2	3	4	5	6	1	2	3	4	5	6
Santa Fe	Jemez													
	S1-A	6	102	102	45	52	54	36	96	88	-81	4	39	7[1]
	S2-A	6	100	106	56	50	47	26	43	92	26	45	47	-12
	S3-A	6	132	123	80	91	64	74	123	123	67	85	64	-2
	Pecos													
	S1-A	6	78	121	65	66	52	39	52	88	24	22	-65	-11
	S2-A	6	99	98	47	52	63	39	72	69	23	-7	20[2]	33
Carson[3]	Amole	2.9		51	63	57				47	59	56		
	Cienega	4		73	76	63				73	68	63		
Cibola	S1-A	6	46	47	17	15	22	19	46	44	-108	-18	5	13
	S1-B	6	47	38	21	18	25	16	47	36	-138	9	24	16
	S2-A	14.4	108	98	53	56	69	70	108	89	-17	15	59	28
Gila	S2-A	6.4	62	45	27	41	30		62	45	27	41	-17	

1/ Includes 15 feet cut in trespass.
2/ Includes 11 feet cut in trespass.
3/ Amole - 10-year, Cienega - 9-year.

Table 5.— Annual increment per acre contributed by "new" trees or those which entered 12-inch class after beginning of record (Santa Fe, Carson, Cibola, and Gila National Forests).

Forest	Plot	Area	1	2	3	4	5	6
			Net annual increment in board feet by 5-year periods					
Santa Fe	Jemez							
	S1-A	6	26	8	0	18	15	28
	S2-A	6	24	23	2	23	8	31
	S3-A	6	28	11	32	11	33	14
	Pecos							
	S1-A	6	25	26	5	27	40	8
	S2-A	6	7	24	12	19	18	13
Carson	Amole	2.9	1/	84	16	133		
	Cienega	4	1/	20	6	34		
Cibola	S1-A	6	23	16	15	5	39	11
	S1-B	6	30	15	12	10	18	42
	S2-A	14.4	44	56	14	14	66	73
Gila	S2-A	6.4	9	11	2	10	14	-

1/ Not measured at end of first 5-year period. Second period covers 9 years on Amole and 10 years on Cienega.

Table 6.- Periodic and mean annual mortality on ponderosa pine sample plots. Santa Fe, Carson, Cibola, and Gila National Forests.

Forest	Plot	Year established	Area	Res. vol. bm[1]	Annual loss per acre in board feet, by 5-year periods						Mean annual loss per acre			
											20 years		30 years	
					1	2	3	4	5	6	Vol.	Percent	Vol.	Percent[2]
			Acres	Feet							Feet		Feet	
Santa Fe	Jemez													
	S1-A	1911	6	5823	6	13	128	49	15	46[3]	49	0.84	43	0.74
	S2-A	1911	6	3821	58	14	32	6	0	38	27	0.71	24	0.63
	S3-A	1911	6	4472	9	0	15	6	0	76	8	0.18	18	0.40
	Pecos													
	S1-A	1911	6	5912	26	33	43	44	119	52	37	0.63	53	0.90
	S2-A	1911	6	6290	27	28	24	59	55[4]	72	34	0.54	44	0.70
Carson[5]	Amole	1914	2.9	1302	[5]	4	7	0			4	0.31		
	Cienega	1915	4	3072		0	8	0			2	0.06		
Cibola	S1-A	1910	6	1954	0	3	128	34	17	6	41	2.10	31	1.59
	S1-B	1910	6	2087	0	2	173	10	0	0	46	2.20	31	1.48
	S2-A	1910	14.4	2982	0	10	70	41	11	41	30	1.01	29	0.97
Gila	S2-A	1912	6.4	2338	0	0	0	0	47	-	0	0		

1/ Volume includes 11.6 and over d.b.h. in year plot was established.
2/ Based on original residual volume.
3/ Includes 15 feet cut in trespass.
4/ Includes 11 feet cut in trespass.
5/ Neither plot measured at end of first 5 years. Cienega plot measured in 9, 14, and 19 years. Period 2 represents 10-year loss for Amole and 9-year loss for Cienega.

Table 7.- Mortality by causes, all species. Percent of original number and volume of trees killed by different agencies.

Forest	Plot	Total stand per acre	Mortality in percent of number of trees: Wind	Mistletoe	Insects	Lightning	Suppression	Cut	Unclassified	Total	Years of record
		No. trees	No. trees	No. trees	No. trees	No. trees	No. trees	No. trees	No. trees	No. trees	
			Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	
Santa Fe											
Jemez	S1-A	64.2	1.29	1.29	2.34	1.31		0.51	0.27	7.01	1911-41
	S2-A	34.8	5.26		1.92	0.49			0.95	8.62	1911-41
	S3-A	52.3	0.32	0.63	1.28	0.63			0.96	3.82	1911-41
Pecos	S1-A	79.5	1.89	3.99	3.99	0.41	0.41		1.89	12.58	1911-41
	S2-A	51.2	0.66	4.24	2.60	0.98	0.97	0.31	1.95	11.72	1911-41
Cibola	S1-A	48.6	8.93	1.38				0.33	1.71	12.35	1910-40
(Datil)	S1-B	87.5	6.48	0.38	0.19				0.95	8.00	1910-40
	S2-A	64.9	2.68	0.11	0.95	0.22			0.85	4.81	1910-40
Gila	S2-A	33.4	0.45	0.48	0.48	0.45				1.86	1912-37

Forest	Plot	Total stand per acre	Mortality in percent of VOLUME: Wind	Mistletoe	Insects	Lightning	Suppression	Cut	Unclassified	Total
		Vol. b.m.	Vol. b.m.	Vol. b.m.	Vol.b.m.	Vol.bm.	Vol.b.m.	Vol. b.m.	Vol.b.m.	Vol.b.m.
		Feet	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Santa Fe										
Jemez	S1-A	5823	4.76	2.09	5.89	6.94		1.27	1.13	22.08
	S2-A	3821	11.62		4.05	2.41			1.18	19.26
	S3-A	4472	0.56	0.40	2.15	7.38			1.36	11.85
Pecos	S1-A	5912	5.90	9.03	7.73	0.95	0.44		2.78	26.83
	S2-A	6290	1.02	7.60	4.93	2.66	0.98	0.86	3.04	21.08
Cibola	S1-A	1954	31.93	8.60				2.25	5.07	47.85
	S1-B	2087	20.03	0.57	0.96				3.02	24.58
	S2-A	2982	17.10	0.10	1.81	7.08			3.02	29.11
Gila	S2-A	2338	0.08	0.34	5.52	4.11				10.05

Table 8.- Mortality per acre and percent of original volume by diameter classes, 30 years, 1911-1941. Ponderosa pine and associated species.[1/] Santa Fe (Jemez and Pecos), Cibola, and Gila National Forests.

D. b. h.	Blackjack		Yellow pine		Douglas-fir, white fir, and limber pine	
	Loss in 30 years		Loss in 30 years		Loss in 30 years	
	Vol.	Pct.	Vol.	Pct.	Vol.	Pct.
	Ft.b.m.		Ft.b.m.		Ft.b.m.	
Jemez S1-A - 6 acres						
12-15	91	13.79				
16-20	48	15.64	407	15.64		
21-25			496	35.00		
31+			223	103.24		
Total	139	14.37	1126*	23.19		
Jemez S2-A - 6 acres						
12-15	12	2.58	56	20.59		
16-20	35	9.92	453	26.60		
21-25	76	122.58	95	9.83		
Total	123	13.96	604	20.54		
Jemez S3-A - 6 acres						
12-15	96	10.08				
16-20	63	6.15	30	22.56		
26-30			330	43.48		
Total	159	5.32	360	25.07		
Pecos S1-A - 6 acres						
12-15	78	8.91	400	26.86		
16-20	48	11.37	829	31.88		
21-25			205	52.03		
Total	126	9.71	1434	31.99		
Pecos S2-A - 6 acres						
12-15	18	12.76	224	20.04	15	11.90
16-20			538	19.34	54	8.61
21-25			295	56.08	182	22.33
Total	18	6.08	1057*	23.88	251	16.01

* - 73 ft. cut.

* - 54 ft. cut.

1/See table 1.

Table 8 (continued)

D. b. h.	Blackjack: Loss in 30 years		Yellow pine: Loss in 30 years		Douglas-fir and limber pine: Loss in 30 years	
	Vol.	Pct.	Vol.	Pct.	Vol.	Pct.
	Ft.b.m.		Ft.b.m.		Ft.b.m.	
			Cibola (Datil) S1-A - 6 acres			
12-15	90	55.90	111	22.79	58	69.05
16-20			240	48.10	209	62.57
21-25					102	68.46
26-30					104	47.27
Total	90	49.72	351	35.60	473	60.10
			Cibola (Datil) S1-B - 6 acres			
12-15	94	42.53	194	46.19	41	46.59
16-20			193	45.95	29	20.57
21-25			76	56.72		
26-30					221	65.19
Total	94	30.03	463	47.54	291	36.42
			Cibola (Datil) S2-A - 14.4 acres			
12-15	115	16.31	61	21.11		
16-20	50	10.87	209	30.60	19	38.78
21-25			37	9.27		
26-30			119	111.21		
31+					255	104.51
Total	165	13.82	426	28.82	274	88.39
			Gila S2-A - 6.4 acres			
			Loss in 25 years			
12-15	10	5.49				
21-25			96	17.71		
26-30			129	60.00		
Total	10	2.40	225	11.71		

1/See table 1.